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AMS ^{14}C chronology of woolly mammoth (*Mammuthus primigenius* Blum.) remains from the Shestakovo upper paleolithic site, western Siberia: Timing of human–mammoth interaction

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Abstract

We present a series of AMS ^{14}C dates from the upper paleolithic site of Shestakovo, southwestern Siberia. The ^{14}C ages range between 21 and 26 ka BP, corresponding to the so-called Sartan Glacial and Karginian Interglacial in Siberia. The majority of dates are from woolly mammoth bones, obtained from several discrete cultural layers, and range from ca. 25,700 to 21,600 BP. One charcoal date, ca. 23,300 BP, pinpoints the timing of at least one phase of site occupation by humans. The overlap of this date with the mammoth bone dates shows clearly that paleolithic people scavenged bones from natural death accumulations near the site. Mammoth hunting was most probably of limited scale. Conventional ^{14}C dates from Shestakovo are also discussed. © 2000 Elsevier Science B.V. All rights reserved.

1. Introduction

The upper paleolithic site of Shestakovo, southwestern Siberia (55°54'N latitude; 87°57'E longitude; Fig. 1), lies along the right bank of the Kiya River, a tributary of the Chulym River (Fig. 2(a)). The bluff-like deposits at Shestakovo are mainly of eolian and colluvial origin, and correspond to the final part of the Karginian

Interstadial (ca. 28,000–24,000 BP), and to the Sartan Glacial (ca. 24,000–18,000 BP) (Fig. 2(b)). Archaeological materials (cultural layers no. 3–8) are assigned to the upper paleolithic on the basis of recovered stone tools and flakes, as well as art objects made from mammoth bone and ivory. Mammal bones were found at Shestakovo in primary association with artifacts. The aim of this paper is to establish the chronological relationships – using AMS ^{14}C dating of both bones and charcoal – between accumulated animal bones and paleolithic human activity at the Shestakovo.

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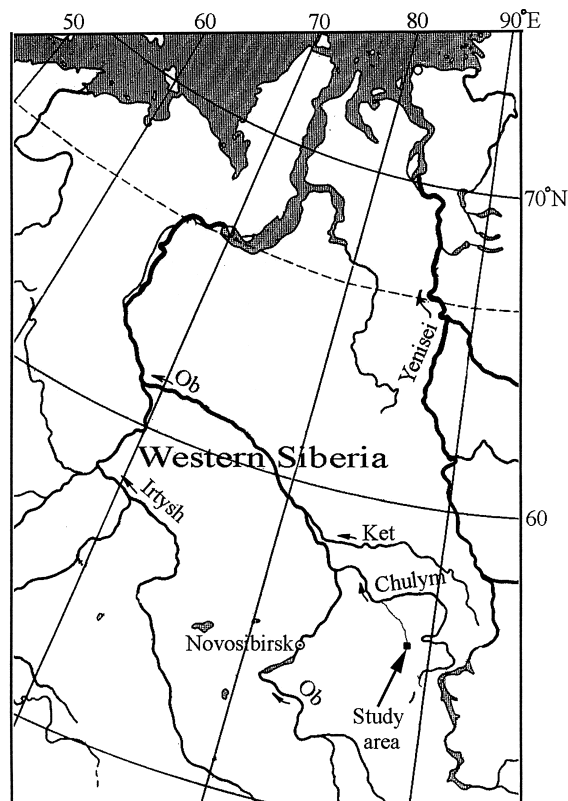


Fig. 1. The position of Shestakovo.

2. Material and methods

Loess-like deposits at Shestakovo (Fig. 3) contain numerous remains of fossil mammals (Fig. 4). The remains of 11 mammal species, all corresponding to the “mammoth faunal complex”, were identified [1]. Among them are woolly mammoth (*Mammuthus primigenius* Blum.), woolly rhinoceros (*Coelodonta antiquitatis* Blum.), reindeer (*Rangifer tarandus* L.), horse (*Equus caballus* L.), bison (*Bison* sp.), korsak fox (*Vulpes corsac* L.), arctic fox (*Alopex lagopus* L.), wolf (*Canis lupus* L.), and hare (*Lepus* sp.). Mammoth remains constitute more than 90% of the total sample of mammal bones at the site [1,2].

Mammal bones and charcoal from the Shestakovo site were ^{14}C dated using AMS in 1998–1999 at the Centre for Isotope Research, University of Groningen. For charcoal, the standard AAA

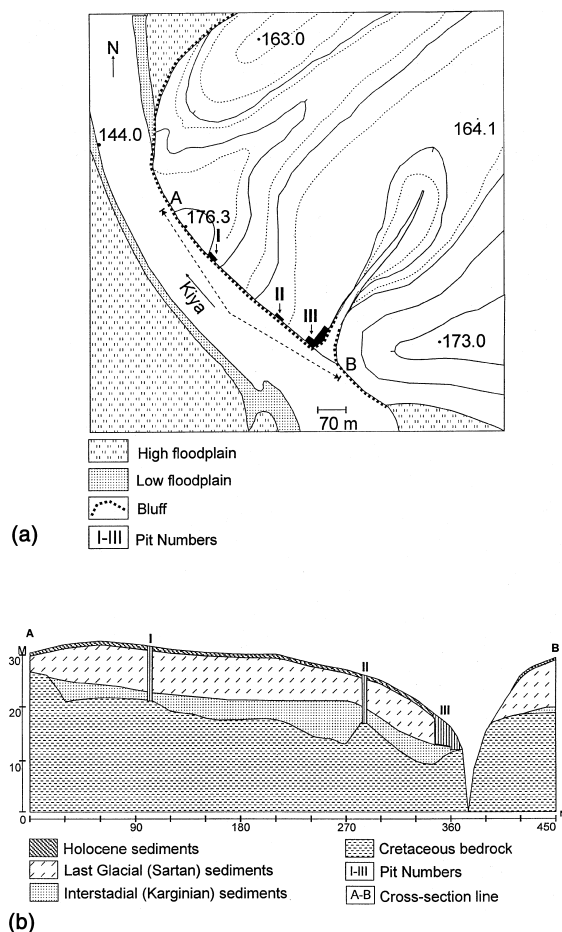


Fig. 2. (a) Geomorphic features of the Shestakovo bluff, and the location of excavations; (b) schematic cross-section of the Shestakovo bluff.

treatment was used, which consists of the following steps:

1. 4% HCl solution at 20°C for 24 h,
2. 1% NaOH at 80°C for 24 h,
3. 4% HCl at 20°C.

For bone material, the datable organic matrix (collagen) was separated using a procedure developed by Longin [3]:

1. 4% HCl at 20°C,
2. thorough washing,
3. acidify slightly and dissolve the collagen at 90°C,
4. remove insoluble contamination (humic) by centrifuging,
5. dry by evaporation at 120°C.

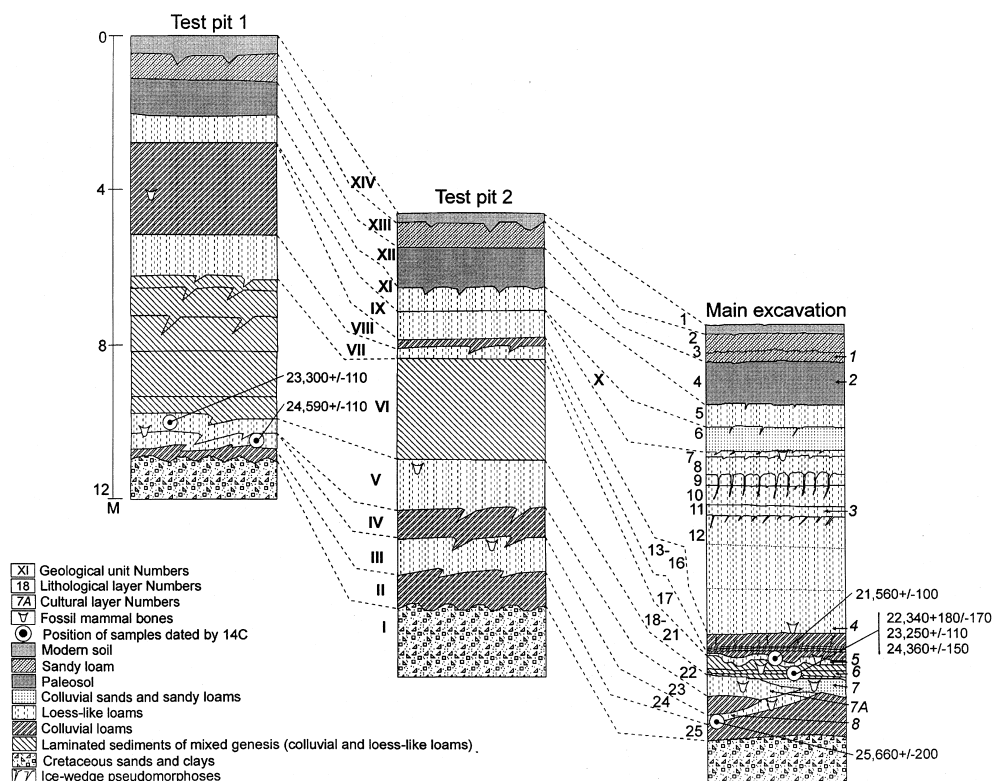


Fig. 3. Detailed stratigraphy, lithology and position of ^{14}C -dated samples on the Shestakovo site (pit numbers correspond to those on Fig. 2(a) and Fig. 2(b); ^{14}C date numbers correspond to those in Table 1).

Criteria to judge the reliability of the chemical purification are the carbon yield (which should be $>40\%$ for both charcoal and collagen), the ash fraction after combustion and the $\delta^{13}\text{C}$ value [4]. The charcoal sample Shestakovo (GrA-13233) has a $\delta^{13}\text{C}$ value of -24.85‰ . The bone collagen samples yielded $\delta^{13}\text{C}$ values in the range from -19.84 to -21.15‰ . Sample GrA-10935 was submitted as “charred bone”. In this case no collagen was extracted; charred bone fragments were pretreated by AAA. For this sample, the carbon yield was 27% and the $\delta^{13}\text{C}$ value was -21.22‰ .

Following the extraction of the carbon-containing fractions (i.e., charcoal and collagen), the samples were combusted using an automatic CN-analyzer [5], which consists of a Cr_2O_3 flash combustion tube, Ag and CuO purification furnaces and a Cu reduction tube, a water trap and a GC column to separate N_2 and CO_2 . This analysis

system is coupled to a stable isotope mass spectrometer (Fisons Optima) for $\delta^{13}\text{C}$ determination. The CO_2 is converted to graphite by reduction with hydrogen gas using Fe powder as a catalyst [6]. The graphite produced is pressed by an automatic press into a target holder, which fits in the carousel of the AMS ion source. The Groningen AMS is a Tandem-based mass spectrometer in operation since 1994 [7,8].

3. Results and discussion

The results obtained are listed in Table 1. The AMS ^{14}C dates are within the chronological interval ca. 25,600–21,500 BP, which corresponds to the transition from the Karginian Interstadial to the Sartan Glaciation. The Groningen ^{14}C dates for Shestakovo are in good agreement with the site stratigraphy (Fig. 3).



Fig. 4. General view of the excavation with mammoth bone concentrations in the layer 19 (cultural layer #6).

We note that the conventional ^{14}C values from the same layers of Shestakovo, obtained previously at the Radiocarbon Laboratory of the Institute of Geology, Siberian Branch of the Russian Academy of Sciences, Novosibirsk, are consistently younger than the Groningen values by 2000–3000 ^{14}C years. However, the Novosibirsk date series is also stratigraphically consistent [9]. Because different samples were dated in the Novosibirsk and Groningen studies, it is difficult to evaluate the reason for the observed discrepancies. Additional tests involving the dating of split samples are required. In addition, we note that each cultural layer of the Shestakovo was

repeatedly occupied over a relatively long period of time [1]. Thus, variation in ^{14}C dates within one cultural layer of up to several thousand years may be expected.

To understand the chronological relationships between the paleolithic occupations at the site and mammoth remains we use both the Groningen and Novosibirsk dates series (Table 1; see also [9]). Two direct ^{14}C dates for the human occupation are on wood charcoal from the main excavation area; layer #19: $23,250 \pm 110$ BP (GrA-13233) (Fig. 3) and $20,800 \pm 450$ BP (SOAN-3606).

Several ^{14}C dates were obtained on unburned animal bones scattered in the cultural layers. Nine

Table 1
AMS ^{14}C dates for the Shestakovo site

No.	Lab code and no.	Geological unit and layer no.	Cultural layer No., location	Material dated	$\delta^{13}\text{C}$ (‰)	^{14}C date (BP)
1	GrA-13235	V (22)	7A (test pit #I)	Mammoth bone	−21.28	23,330 ± 110
2	GrA-13239	III (24)	Test pit #I	Horse bone	−19.84	24,590 ± 110
3	GrA-13234	VII (17)	5, main excavation	Mammoth tooth	−20.50	21,560 ± 100
4	GrA-13240	VI (19)	6, main excavation	Mammoth bone	−20.89	22,340 ± 180/ − 170
5	GrA-13233	VI (19)	6, main excavation	Charcoal	−24.85	23,250 ± 110
6	GrA-10935	VI (19)	6, main excavation	Burnt mammoth bone	−21.22	24,360 ± 150
7	GrA-13238	III (24)	Main excavation	Mammoth bone	−21.15	25,660 ± 200

dates were obtained on mammoth bones: (1) 25,660 ± 200 BP (GrA-13238) from the main excavation, layer #24; (2) 23,330 ± 110 BP (GrA-13235) from the basal layer in pit #1; (3) 22,240 ± 185 BP (SOAN-3612) from the main excavation, layer #22; (4) 21,300 ± 420 BP (SOAN-3611) from the main excavation, layer #21; (5) 20,480 ± 180 BP (SOAN-3607) from the main excavation, layer #19; (6) 22,340 ± 180/−170 BP (GrA-13240) from the main excavation, top of layer #19; (7) 19,190 ± 310 BP (SOAN-3609) from the main excavation, contact of layers #17 and 18; (8) 18,040 ± 175 BP (SOAN-3610) from the main excavation, layer #17; and (9) 21,560 ± 100 BP (GrA-13234) from the main excavation, layer #17. Other unburned animal bones were dated to 24,590 ± 110 BP (GrA-13239) (horse from the basal part of pit #1) and to 20,360 ± 210 BP (SOAN-3608) (reindeer and horse from the main excavation, layer #19). Two dates were run on burned mammoth bones from layer #19: 24,360 ± 150 BP (GrA-10935); and 20,770 ± 560 BP (SOAN-3218).

Analysis of both date series, particularly those from geological layer #19 (corresponds to cultural layer #6) in the main excavation area, shows that paleolithic people coexisted on the landscape with mammoths. Human-related dates from layer #19 range from ca. 20,800 to 23,250 BP. Mammoth dates from layer #19 vary from ca. 22,340 to ca. 24,360 BP in the Groningen date series (Table 1), and from ca. 20,480 to ca. 20,770 BP in the Novosibirsk date series [9]. The substantially older dates from mammoth bones in layer #19 indicate

that ancient people scavenged sub-fossil mammoth bones for different purposes.

Taphonomic observations of the Shestakovo faunal assemblage show that several mammoth bones retain traces of extensive surficial weathering, indicating prolonged exposure to the open air. A number of specimens also preserve carnivore tooth marks. The interior matrix of these bones show no indications of plant root activity. The degree of preservation (both surficial and interior) for other species is significantly better [1]. This contrast indicates that paleolithic people collected fossil and sub-fossil mammoth bones and brought them to the occupation place. Bones from other animals most likely represent kills transported to the site as part of specialized hunting activities. The Series of AMS ^{14}C dates support this conclusion.

The peculiarities concerning the sex and age composition of mammoths found at the Shestakovo locality also indicate that human activity was of minor importance with respect to accumulation of mammoth bones [1,2,9]. It is possible that the paleolithic site was located directly near the place where the animals died, and where the mammoth bones gradually accumulated over a long period of time. Taking into account the widespread occurrence of mammoth bones, their taphonomic features, and chemical composition of the sediments, we suggest that mammoths and other animals were attracted to Shestakovo because of natural salts occurring within the outcrops [2]. Thus, the bone concentrations can be explained by the existence of salt licks near Shestakovo [1,2].

The spatial and temporal coincidence of cultural remains and animal bones in deposits of different origins is quite common for many regions of Eurasia, and in general this feature may be explained by the dependence of paleolithic humans on mammals as a primary food source [10,11]. Occasionally, paleolithic artifacts are found in association with mass accumulations of animal bones. Many of these associations may reflect the placement of occupation sites near natural concentrations of animal bones in alluvial deposits such as at Berelekh [12], or near local geochemical anomalies such as salt licks. The existence of animal bone accumulations around a salt lick at Shestakovo may have been the primary reason for paleolithic occupation of the site.

4. Conclusion

The data obtained show that Shestakovo is a clear example of mammal bone concentration due to paleolandscape conditions. The results of AMS ^{14}C dating support the subdivision of Upper Pleistocene deposits at Shestakovo, and allow us to establish broad coexistence of paleolithic humans and mammoths in southwestern Siberia. The main period of human activity at Shestakovo corresponds to the time interval ca. 25,600–18,000 BP, and correlates in general with timing of mass accumulation of mammal bones. It is clear that at least ca. 20,800–23,300 BP paleolithic humans collected mammoth bones from a natural animal “cemetery” near the settlement. Mammoths existed in this part of Western Siberia during at least ca. 25,700–18,000 BP, according to the Shestakovo

^{14}C date series. Human hunting probably had only a limited effect on mammoth populations.

Acknowledgements

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